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37 CFR 1.78(f) DISCLOSURE OF CLOSELY RELATED APPLICATIONS AND 1.78(F)(2)(ii)(A) REBUTTAL OF PRESUMPTIONS

ASSISTANT COMMISSIONER FOR PATENTS

ALEXANDRIA, VA 22313

Sir:

The applicant submits this paper to comply with the new requirements in 37 CFR 1.78(f).

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I. THE SUBJECT APPLICATION

Application No: 09/307,988

Filing Date: 5/10/1999

Priority dates/claims: This application is a continuation of application Serial No. 08/816,097, filed March 14, 1997, which is a continuation-in-part of parent application Serial No. 08/549,385, filed October 27, 1995.

II. CLOSELY RELATED APPLICATIONS WITHIN THE MEANING OF 1.78(f)(1)

A. CRITERIA

The applications listed below include the applications that meet the following criteria:

1. Pending or issued;
2. has any priority date (including non provisional, provisional, foreign, and PCT claimed priority dates) within 2 months of any priority date (including non provisional, provisional, foreign, and PCT claimed priority dates) claimed by the subject application;
3. names at least one inventor in common with the subject application; and
4. is owned by or subject to an obligation to assign to the same entity as the subject application.

B. LIST OF 1.78(F)(1) CLOSELY RELATED APPLICATIONS

1. US Patent No: 5,782,822

Status: Issued

Neifeld Docket No: VISX0017U/US

Applicability of 37 CFR 1.78(f)(2): This application and the subject application have the same priority date of October 27, 1995.

2. US Patent No: 6,090,102

Status: Issued

Neifeld Docket No: VISX0016U/US

Applicability of 37 CFR 1.78(f)(2): This application and the subject application have the same

priority date of October 27, 1995.

3. US Application No: 10/996,458

Status: Pending

Neifeld Docket No: VISX0011U-US-C1

Applicability of 37 CFR 1.78(f)(2): This application and the subject application have the same priority date of October 27, 1995.

III. APPLICATIONS FOR WHICH THERE IS A 1.78(f)(2)(i) REBUTTABLE PRESUMPTION DUE TO A COMMON FILING DATE

US Patent No: 5,782,822

US Patent No: 6,090,102

US Application No: 10/996,458

IV. 1.78(f)(2)(ii)(A) REBUTTAL OF THE 1.78(f)(2)(i) PRESUMPTIONS

A. CLAIMS IN THE SUBJECT APPLICATION

The independent claims in the subject application read as follows.

61. A surgical method, comprising:

generating a pump beam pulse;

transmitting said pump beam pulse into a KTP crystal along a propagation direction that is substantially not parallel to a principle axis of said KTP crystal;

wherein said KTP crystal converts a fraction of energy in said pump beam pulse into an idler beam pulse, and said idler beam pulse has a wavelength of between about 2.75 and about 3.0 microns; and

impinging said idler beam pulse on tissue, thereby removing said tissue.

80. A surgical method, comprising:

generating a pump beam pulse;

transmitting said pump beam pulse through a mirror that is highly reflective to a

wavelength of an idler beam pulse and highly transmissive to a wavelength of said pump beam pules, said mirror oriented at an angle of forty five degrees relative to said pump beam pulse;
transmitting said pump beam pulse into a crystal;
wherein said crystal converts a fraction of energy in said pump beam pulse into said idler beam pulse, and said idler beam pulse wavelength is about 2.90 and about 3.0 microns; and
impinging said idler beam pulse on tissue, thereby removing said tissue.

81. A surgical method, comprising:
generating a pump beam pulse;
transmitting said pump beam pulse into a periodically poled KTP crystal;
wherein said KTP crystal converts a fraction of energy in said pump beam pulse into an idler beam pulse, and said idler beam pulse has a wavelength of between about 2.75 and about 3.0 microns; and
impinging said idler beam pulse on tissue, thereby removing said tissue.

82. A surgical method, comprising:
generating a pump beam pulse;
transmitting said pump beam pulse into a periodically poled LiNbO3 crystal;
wherein said periodically poled LiNbO3 crystal converts a fraction of energy in said pump beam pulse into an idler beam pulse, and said idler beam pulse has a wavelength of between about 2.9 and about 3.0 microns; and
impinging said idler beam pulse on tissue, thereby removing said tissue.

83. A surgical method, comprising:
generating a pump beam pulse at a wavelength of between about 0.85 and 0.90 microns;
transmitting said pump beam pulse into a non critically phase matched KTP crystal, Xcut;
wherein said non critically phase matched KTP crystal converts a fraction of energy in said pump beam pulse into an idler beam pulse, and said idler beam pulse has a wavelength of between about 2.9 and about 3.0 microns; and
impinging said idler beam pulse on tissue, thereby removing said tissue.

90. A surgical method, comprising:
generating a pump beam pulse;

transmitting said pump beam pulse into a crystal along a propagation direction;
wherein said crystal converts a fraction of energy in said pump beam pulse into an idler beam pulse, and said idler beam pulse has a wavelength of between about 2.75 and about 3.0 microns, a pulse width of not more than 50 nanoseconds, and an energy of at least 5 millijoules; and
impinging said idler beam pulse on tissue, thereby removing said tissue.

C. REBUTTAL OF PRESUMPTION FOR USP 5,782,822

The claims in USP 5,782,822 read as follows:

1. A medical apparatus for removing corneal tissue from an eye of a patient, said apparatus comprising:

a laser source that produces pulses of mid-infrared radiation, wherein said infrared radiation has a wavelength approximately corresponding to a corneal absorption peak, and wherein said pulses have a duration of at least about 1 nanosecond; and

a scanner-deflection means to direct the pulsed radiation across an area of said corneal tissue in a predefined pattern to remove portions of said corneal tissue primarily by photospallation.

2. The apparatus according to claim 1, wherein said corneal tissue is removed to correct the curvature of said cornea.

3. The apparatus according to claim 1, wherein said corneal tissue is removed to affect a therapeutic intervention.

4. The apparatus according to claim 1, wherein said beam has a pulse duration of less than about 50 nanoseconds.

5. The apparatus according to claim 1, further comprising an eye tracker means to sense and

compensate for movements of the eye.

6. The apparatus according to claim 1, wherein said laser source is coupled to said scanner deflection means by a decoupled laser delivery system.

7. The apparatus according to claim 1, wherein said laser source is an erbium YAG laser producing infrared radiation at a wavelength of 2.94 microns.

8. The apparatus according to claim 1, wherein said pulsed beam is generated by a solid state laser emitting radiation in the range of approximately 1 to 2 microns and further comprising an optical parametric oscillator for frequency shifting said radiation to a wavelength of approximately 3 microns.

9. The apparatus according to claim 1, wherein said laser source is a solid state laser producing infrared radiation at a wavelength in the range 2.7 to 3.1 microns.

10. The apparatus according to claim 1, wherein the energy in each of said pulses is between about 5 mJ and about 30 mJ.

11. The apparatus according to claim 1, wherein said scanner deflection means produces a spot size in the range of about 0.3 mm to about 2 mm.

12. The apparatus according to claim 1, further comprising a corneal topography device for evaluating the shape of said corneal tissue.

13. The apparatus according to claim 1, wherein said corneal tissue is removed to alter the refractive properties of said eye and further comprising a spatially resolved refractometer for evaluating the refraction of said corneal tissue.

14. A method for removing corneal tissue from an eye of a patient, said method comprising the steps of:

generating a pulsed beam of laser radiation for ablating said corneal tissue, wherein said beam comprises mid-infrared radiation at a wavelength approximately corresponding to a corneal absorption peak, and wherein said beam has a pulse duration of at least about 1 nanosecond; and

scanning said beam across an area of said corneal tissue in a predefined pattern to remove portions of said corneal tissue primarily by photospallation.

15. The method according to claim 14, wherein said corneal tissue is removed to correct the curvature of said cornea.

16. The method according to claim 14, wherein said corneal tissue is removed to affect a therapeutic intervention.

17. The method according to claim 14, wherein said beam has a pulse duration of less than about 50 nanoseconds.

18. The method according to claim 14, wherein said pulsed beam is generated by an erbium YAG laser producing infrared radiation at a wavelength of 2.94 microns.

19. The method according to claim 14, wherein said pulsed beam is generated by a solid state laser emitting radiation in the range of approximately 1 to 2 microns and further comprising the step of frequency shifting said radiation to a wavelength of approximately 3 microns utilizing an optical parametric oscillator.

20. The method according to claim 14, wherein said pulsed beam is generated by a solid state laser producing infrared radiation at a wavelength in the range 2.7 to 3.1 microns.

21. The method according to claim 14, further comprising the step of tracking the movement of said eye to ensure said beam is directed upon said corneal tissue.

22. The method according to claim 14, wherein said step of scanning said beam across said corneal tissue is performed in a discontinuous fashion to minimize collateral damage to said eye.

23. The method according to claim 14, wherein the energy in each of said pulses is between about 5 mJ and about 30 mJ.

24. The method according to claim 14, wherein said scanning step utilizes a spot size in the range of about 0.3 mm to about 2 mm.

25. The method according to claim 14, further comprising the step of evaluating the shape of said corneal tissue using an on-line corneal topography device.

26. The method according to claim 14, wherein said corneal tissue is removed to alter the refractive properties of said eye and further comprising the step of evaluating the refraction of said corneal tissue using a spatially resolved refractometer.

The claims in USP 5,782,822 do not disclose or suggest the subject matter defined by the pending independent claims, claims 61, 80, 81, 82, 83, and 90.

The claims in USP 5,782,822 do not disclose or suggest the KTP crystal defined by independent claims 61, 81, 83.

The claims in USP 5,782,822 do not disclose or suggest mirror oriented at an angle of forty five degrees relative to said pump beam pulse as defined by independent claim 80.

The claims in USP 5,782,822 do not disclose or suggest the periodically poled LiNbo3 as defined by independent claim 82.

The claims in USP 5,782,822 do not disclose or suggest transmitting said pump beam

pulse into a crystal along a propagation direction, as defined by independent claim 90.

D. REBUTTAL OF PRESUMPTION FOR USP 6,090,102

The claims in USP 6,090,102 read as follows:

1. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity operatively configured and adapted to produce a laser beam having a wavelength in the mid-infrared range, from about 2.5 to about 4.0 um, and which wavelength corresponds approximately to an absorption peak of said tissue, said laser rod being pumped by a pump source; and

an electro-optical Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is less than about 30 cm and sufficiently short to provide pulse durations shorter than 50 ns.

2. The laser system according to claim 1, wherein said laser rod is erbium-doped.

3. The laser system according to claim 2, wherein the erbium concentration of said rod is at about a 25-40% doping level.

4. The laser system according to claim 1, wherein the host of the active ion of said laser rod is comprised of YALO, YLF, YSGG or YAG.

5. The laser system according to claim 1, further comprising means for directing said laser beam onto said tissue to remove portions of said tissue primarily by a photo-mechanical ablation process.

6. The laser system according to claim 1, wherein an output coupling surface is coated onto one end of said laser rod.

7. The laser system according to claim 1, wherein said pump source is a flashlamp.

8. The laser system according to claim 1, wherein said pump source is a diode array.

9. The laser system according to claim 8, wherein said diode array pumps said laser rod in a side-pumped configuration.

10. The laser system according to claim 8, wherein said diode array pumps said laser rod in an end-pumped configuration.

11. The laser system according to claim 8, whereby an overall repetition rate of at least 20 Hz is achieved.

12. The laser system according to claim 1, wherein said pulses are produced at a repetition rate of at approximately 10 Hz.

13. The laser system according to claim 1, wherein said Q-switch is comprised of lithium niobate.

14. The laser system according to claim 1, wherein said surgical procedure is a corneal ablation procedure.

15. The laser system according to claim 14, wherein said corneal ablation procedure is based on a photospallation mechanism.

16. The laser system according to claim 14, wherein the fluence onto the eye is between 50 mJ/cm.sup.2 and 200 mJ/cm.sup.2.

17. The laser system according to claim 1, wherein said surgical procedure is an endoscopic procedure or a micro-surgical procedure.

18. The laser system according to claim 1, wherein a high reflecting surface is coated onto one end of said laser rod.

19. The laser system according to claim 1, wherein the resonator cavity is less than about 20 cm.

20. The laser system according to claim 1, wherein the hold-off voltage for producing the beam is less than about 2.5 KV.

21. The laser system according to claim 1, wherein the host of the active ion of said laser rod is selected from the group consisting of: garnet, an oxide or a fluoride crystal.

22. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity operatively configured and adapted to produce a laser beam having a wavelength in the mid-infrared range approximately between about 2.7 and about 3.0, said laser rod being pumped by a pump source; and

an electro-optical Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is less than about 30 cm and sufficiently short to provide pulse durations shorter than 50 ns.

23. The laser system according to claim 22, wherein the resonator cavity is less than about 20 cm.

24. The laser system according to claim 22, wherein the hold-off voltage for producing the beam is less than about 2.5 KV.

25. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a laser beam in the mid-infrared range approximately between 2.79 and 3.02 .mu.m;

oscillating said beam in a resonator cavity; and

controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns.

26. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue;

oscillating said beam in a resonator cavity; and

controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns.

27. A method for removing corneal tissue from an eye of a patient, said method comprising the steps of:

generating a laser beam in the mid-infrared range approximately to an absorption peak of said corneal tissue;

oscillating said beam in a resonator cavity;

controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns; and

directing said beam across an area of said corneal tissue in a predefined pattern to remove portions of said corneal tissue primarily by a photo-mechanical ablation process.

28. A mid-infrared laser system for removing corneal tissue from any eye of a patient, said system comprising:

a laser resonator cavity;

a laser rod within said cavity operatively configured and adapted to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said corneal tissue, said laser rod being pumped by a pump source;

an electro-optical Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns; and

means for directing said laser beam onto said eye in a pre-defined pattern to remove portions of said corneal tissue primarily by a photo-mechanical ablation process.

29. The laser system according to claim 28, wherein the resonator cavity is less than about 30 cm.

30. The laser system according to claim 28, wherein the resonator cavity is less than about 20 cm.

31. The laser system according to claim 28, wherein the hold-off voltage for producing the beam is less than about 2.5 KV.

32. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity, said laser rod being pumped by a pump source to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

a Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and wherein the ends of said laser rod are cut at the Brewster angle.

33. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system

comprising:

a laser resonator cavity;

a laser rod within said cavity, said laser rod being pumped by a pump source to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

a Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is less than about 30 cm and sufficiently short to provide pulse durations shorter than 50 ns and wherein the ends of said Q-switch material are cut at the Brewster angle.

34. The laser system according to claim 33, wherein the resonator cavity is less than about 20 cm.

35. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity, said laser rod being pumped by a pump source to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

a Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and wherein said pump source is a diode array, and wherein said diode array pumps said laser rod in an end-pumped configuration, and wherein said laser rod is comprised of a plurality of sections N, each end-pumped individually, whereby an overall repetition rate of at least 20 Hz*N is achieved in a laser beam combined by a beam delivery system.

36. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is less than about

30 cm and sufficiently short to provide pulse durations shorter than 50 ns and wherein said laser rod is erbium-doped.

37. The laser system according to claim 36, wherein the resonator cavity is less than about 20 cm.

38. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and

controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns;

directing said laser beam onto said tissue to remove portions of said tissue primarily by a photo-mechanical ablation process.

39. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and the pulses are produced at a repetition rate of at least approximately 10 Hz.

40. A method for performing a laser surgical procedure on a tissue, said procedure being selected from the group consisting of: a corneal ablation procedure, an endoscopic procedure and a micro-ocular procedure, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and

controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is less than about 30 cm and sufficiently short to provide pulse durations shorter than 50 ns.

41. The laser system according to claim 40, wherein the resonator cavity is less than about 20 cm.

42. A method for performing a corneal ablation procedure based on a photospallation mechanism, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and

controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is less than about 30 cm and sufficiently short to provide pulse durations shorter than 50 ns.

43. The laser system according to claim 42, wherein the resonator cavity is less than about 20 cm.

44. A method for performing a corneal ablation procedure based on a photospallation mechanism, wherein the fluence onto the eye is between 50 mJ/cm.sup.2 and 200 mJ/cm.sup.2, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns.

45. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using a laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam; wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and the hold-off voltage for generating the laser beam is less than about 2.5 KV.

46. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity, said laser rod being pumped by a pump source to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

a Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and wherein the hold-off voltage for generating the laser beam is less than about 2.5 KV.

47. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity, said laser rod being pumped by a pump source to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

a Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and wherein pulses are produced at a repetition rate of at least approximately 10 Hz.

48. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser resonator cavity;

a laser rod within said cavity, said laser rod being pumped by a pump source to produce a laser beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

a Q-switch to control the oscillation of said laser beam within the resonator cavity to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 50 ns and wherein said pump source is a diode array.

49. A method for performing a corneal ablation procedure based on a photospallation mechanism, wherein the fluence onto the eye is between 50 mJ/cm.sup.2 and 200 mJ/cm.sup.2, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 70 ns.

50. A method for performing a corneal ablation procedure based on a photospallation mechanism, wherein the threshold fluence for obtaining ablation less than about 100 mJ/cm.sup.2, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 70 ns.

51. A method for performing a corneal ablation procedure based on a photospallation mechanism, wherein the thermal damage zone generated by the ablation procedure is less than 2 um, said method comprising the steps of:

generating a laser beam in the mid-infrared range corresponding approximately to an absorption peak of said tissue using an erbium-doped laser rod;

oscillating said beam in a resonator cavity; and controlling said oscillation using a Q-switch to produce pulses of said laser beam, wherein the length of said resonator cavity is sufficiently short to provide pulse durations shorter than 70 ns.

The claims in USP 6,090,102 do not disclose or suggest the subject matter defined by the pending independent claims, claims 61, 80, 81, 82, 83, and 90.

The claims in USP 6,090,102 do not disclose or suggest the KTP crystal defined by independent claims 61, 81, 83.

The claims in USP 6,090,102 do not disclose or suggest mirror oriented at an angle of forty five degrees relative to said pump beam pulse as defined by independent claim 80.

The claims in USP 6,090,102 do not disclose or suggest the periodically poled LiNbo3 as defined by independent claim 82.

The claims in USP 6,090,102 do not disclose or suggest transmitting said pump beam pulse into a crystal along a propagation direction, as defined by independent claim 90.

E. REBUTTAL OF PRESUMPTION FOR US APPLICATION NO: 10/996,458

The claims pending in US Application No: 10/996,458 read as follows.

1. An apparatus for tracking the movement of an eye of a patient, comprising: a first light source; optical components for directing light generated by said first light source to said eye along a first light source path; a tracking light source; wherein tracking light generated by said tracking light source propagates to said eye along a tracking light source path; wherein portions of said tracking light source path and said first light source path that are adjacent said eye are nearly angularly co-incident with one another; optics for imaging on a detector plane tracking light reflected from said eye to thereby form a reflected tracking light image of a cornea and a sclera of said eye; and a detector array at said detector plane.
2. The apparatus of claim 1 wherein portions of said tracking light source path and said first light source path that are adjacent said eye form an angle on the order of 8 degrees relative to one another.
3. The apparatus of claim 1 further comprising a video camera detector, and said video camera detector and said detector array detector do not receive light along the same optical path.
4. The apparatus of claim 1 further comprising means for generating a null signal when said image is centered on said detector array.
5. The apparatus of claim 1 further comprising means for generating a null signal when first light source path is aligned with said eye.
6. The apparatus of claim 1 further comprising means for generating an error signal proportional to the deviation of said image from a center of said detector array.
7. The apparatus of claim 1 further comprising means for maintaining an approximately centered condition between an optical axis of said laser beam and said eye based on an error signal generated by said detector array.
8. The apparatus of claim 1 further comprising a mirror for reflecting and light generated by said first light source.

9. The apparatus of claim 8 further comprising a means for deflecting said mirror.

10. The apparatus of claim 1, wherein said tracking light has a wavelength of approximately 0.8 um to approximately 1.0 .um and said light generated by said first light source has a mid-infrared wavelength.

11. The apparatus of claim 1 further comprising means for modulating intensity of said tracking light at a predefined frequency.

12. The apparatus of claim 1 further comprising one or more red filters in front of said detector array.

13. The apparatus of claim 1 further comprising one or more infra red filters in front of said detector array.

14. The apparatus of claim 1 wherein said tracking light source generates is a laser capable of generating pulses having an inter pulse duration of less than ten milliseconds.

15. The apparatus of claim 1 further comprising means for synchronizing said detector array to a frequency.

16. The apparatus of claim 1 wherein said first light source is a laser capable of ablating or photo spallating tissue of said eye.

17. The apparatus of claim 1 wherein said detector array comprises a plurality of detector elements; and wherein each one of said plurality of detector elements is located in said detector plane at a position that does not image a center region of said cornea when said eye is aligned with said first path.

18. An method for tracking the movement of an eye of a patient, comprising: directing light generated by a first light source to said eye along a first light source path; propagating tracking light to said eye along a tracking light source path; wherein portions of said tracking light source path and said first light source path that are adjacent said eye are nearly angularly co-incident with one another; forming a reflected tracking light image of a cornea and a sclera of said eye at a detector plane; and detecting reflected tracking light in said detector plane with a detector array.

19. The method of claim 18 wherein portions of said tracking light source path and said first light source path that are adjacent said eye form an angle on the order of 8 degrees relative to one another.

20. The method of claim 18 further comprising receiving light in a video camera detector, and said video camera detector and said detector array do not receive light along the same optical path.

21. The method of claim 18 further comprising means for generating a null signal when said image is centered on said detector array.

22. The method of claim 18 further comprising means for generating a null signal when first light source path is aligned with said eye.

23. The method of claim 18 further comprising means for generating an error signal proportional to the deviation of said image from a center of said detector array.

24. The method of claim 18 further comprising means for maintaining an approximately centered condition between an optical axis of said laser beam and said eye based on an error signal generated by said detector array.

25. The method of claim 18 further comprising a mirror for reflecting and light generated by said first light source.

26. The apparatus of claim 25 further comprising a means for deflecting said mirror.

27. The method of claim 18, wherein said tracking light has a wavelength of approximately 0.8 um to approximately 1.0 .um and said light generated by said first light source has a mid-infrared wavelength.

28. The method of claim 18 further comprising means for modulating intensity of said tracking light at a predefined frequency.

29. The method of claim 18 further comprising one or more red filters in front of said detector array.

30. The method of claim 18 further comprising one or more infra red filters in front of said detector array.

31. The method of claim 18 wherein said tracking light source generates is a laser capable of generating pulses having an inter pulse duration of less than ten milliseconds.

32. The method of claim 18 further comprising means for synchronizing said detector array to a frequency.

33. The method of claim 18 wherein said first light source is a laser capable of ablating or photo

spallating tissue of said eye.

34. The method of claim 18 wherein said detector array comprises a plurality of detector elements each of which is located in said detector plane at a position that does not image a center region of said cornea when said eye is aligned with said first path.

35. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising: a laser source for producing a pump beam; a nonlinear crystal for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and a mirror for directing said idler beam onto said tissue to remove portions of said tissue to ablate said tissue; and wherein said system is designed to propagate said idler beam from said mirror to said tissue without said idler beam contacting any other optical elements.

36. The system of claim 35, wherein said pump beam has a pulse duration of less than 50 ns.

37. The system pf claim 35, wherein said idler beam has energy output of at least 5 mJ.

38. The system of claim 35 further comprising a scanner-deflector including said mirror for scanning said idler beam.

39. The system of claim 35, wherein said system is designed for producing a refractive correction.

40. The system of claim 35, wherein said pump beam has a pulse duration of less than about 25 nanoseconds.

41. The system of claim 35, further comprising an eye tracker to sense and compensate for movements of the eye during a procedure.

42. The system of claim 35, wherein said laser source is coupled to said mirror by a decoupled laser delivery system.

43. The system of claim 35, wherein said laser source is an erbium YAG laser.

44. The system of claim 35, wherein said laser source is a solid state laser emitting radiation in the range of approximately 1 to 2 microns.

45. The system of claim 35, wherein said laser source is designed to produce pulses, and energy in one of said pulses is between about 5 mJ and about 30 mJ.

46. The system of claim 35, wherein said system is designed to produce a spot size on an anterior

surface of said tissue having a dimension in the range of about 0.3 mm to about 2 mm.

47. The system of claim 35, further comprising a corneal topography device for evaluating the shape of an anterior surface of said tissue.

48. The system of claim 35, wherein said tissue is corneal tissue, and further comprising a spatially resolved refractometer for evaluating the refraction of said corneal tissue.

49. The system of claim 35 wherein said tissue is corneal tissue.

50. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising: a laser source for producing a pump beam; a nonlinear crystal for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; structure for directing said idler beam onto said tissue to remove portions of said tissue; and wherein said system comprises optical elements, and said structure is designed to form said idler beam into an image of an aperture of one of said optical elements at an anterior surface of said tissue.

51. The system of claim 50, wherein said pump beam has a pulse duration of less than 50 ns.

52. The system pf claim 50, wherein said idler beam has energy output of at least 5 mJ.

53. The system of claim 50, wherein said structure comprises a scanner-deflector.

54. The system of claim 50, wherein said aperture is an output aperture of a lens.

55. The system of claim 50, wherein said aperture is an output aperture of one or more optical fibers.

56. The system of claim 50, wherein said system is designed for producing a refractive correction.

57. The system of claim 50, wherein said pump beam has a pulse duration of less than about 25 nanoseconds.

58. The system of claim 50, further comprising an eye tracker to sense and compensate for movements of the eye during a procedure.

59. The system of claim 50, wherein said laser source is coupled to said structure by a decoupled laser delivery system.

60. The system of claim 50, wherein said laser source is an erbium YAG laser.

61. The system of claim 50, wherein said laser source is a solid state laser emitting radiation in the wavelength range of approximately 1 to 2 microns.

62. The system of claim 50, wherein said laser source is designed to produce pulses, and energy in one of said pulses is between about 5 ml and about 30 mJ.

63. The system of claim 50, wherein said system is designed to produce a spot size on an anterior surface of said tissue having a dimension in the range of about 0.3 mm to about 2 mm.

64. The system of claim 50, further comprising a corneal topography device for evaluating the shape of an anterior surface of said tissue.

65. The system of claim 50, wherein said tissue is corneal tissue, and further comprising a spatially resolved refractometer for evaluating the refraction of said corneal tissue.

66. The system of claim 50 wherein said tissue is corneal tissue.

67. A medical apparatus for removing corneal tissue from an eye of a patient primarily by photo spallation, said apparatus comprising: a laser system that produces pulses of mid-infrared radiation, wherein said infrared radiation has a wavelength approximately corresponding to a corneal absorption peak, and wherein said pulses have a duration of at least about 1 nanosecond; a scanner-deflection means to direct the pulsed radiation across an area of said corneal tissue in a predefined pattern to remove portions of said corneal tissue; wherein said scanner-deflection means includes a mirror designed to redirect pulses towards said corneal tissue; and said laser system includes no elements between said mirror and said corneal tissue.

68. A medical apparatus for removing corneal tissue from an eye of a patient primarily by photo spallation, said apparatus comprising: a laser system that produces pulses of mid-infrared radiation, wherein said infrared radiation has a wavelength approximately corresponding to a corneal absorption peak, and wherein said pulses have a duration of at least about 1 nanosecond; and a scanner-deflection means to direct the pulsed radiation across an area of said corneal tissue in a predefined pattern to remove portions of said corneal tissue; and wherein said laser system is designed to image an output aperture of an optical element of said apparatus on said corneal tissue.

69. A method for using a mid-infrared laser system for performing a laser surgical procedure on a tissue, comprising: producing a pump beam using a laser source; parametrically converting the

pump beam into an idler beam and a signal beam, using a nonlinear crystal, said idler beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and directing said idler beam onto said tissue using a mirror, to remove portions of said tissue to ablate said tissue; and propagating said idler beam from said mirror to said tissue without said idler beam contacting any other optical elements.

70. The method of claim 69, wherein said pump beam has a pulse duration of less than 50 ns.

71. The method of claim 69, wherein said idler beam has energy output of at least 5 mJ.

72. The method of claim 69 further comprising scanning said idler beam using a scanner-deflector including said mirror.

73. The method of claim 69, further comprising producing a refractive correction.

74. The method of claim 69, wherein said pump beam has a pulse duration of less than about 50 nanoseconds.

75. The system of claim 69, further comprising sensing and compensating for movements of the eye during a procedure, using an eye tracker.

76. The method of claim 69, decoupling said laser source and said mirror using a decoupled laser delivery system.

77. The method of claim 69, wherein said laser source is an erbium YAG laser.

78. The method of claim 69, wherein said laser source is a solid state laser emitting radiation in the wavelength range of approximately 1 to 2 microns.

79. The method of claim 69, wherein said laser source is designed to produce pulses, and energy of one of said pulses is between about 5 mJ and about 30 mJ.

80. The method of claim 69, further comprising producing a spot size on an anterior surface of said tissue having a dimension in the range of about 0.3 mm to about 2 mm.

81. The method of claim 69, evaluating the shape of an anterior surface of said tissue using a corneal topography device.

82. The method of claim 69, wherein said tissue is corneal tissue, and further comprising evaluating the refraction of said corneal tissue using a spatially resolved refractometer.

83. The method of claim 69 wherein said tissue is corneal tissue.

84. A method for performing a laser surgical procedure on a tissue using a mid-infrared laser

system, comprising: producing a pump beam using a laser source; parametrically converting the pump beam into an idler beam and a signal beam using a nonlinear crystal, said idler beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; directing said idler beam onto said tissue using structure, to remove portions of said tissue; and wherein said system comprises optical elements, and said structure is designed to form said idler beam into an image of an aperture of one of said optical elements at an anterior surface of said tissue.

85. The method of claim 84, wherein said pump beam has a pulse duration of less than 50 ns.

86. The method pf claim 84, wherein said idler beam has energy output of at least 5 mJ.

87. The method of claim 84, wherein said structure comprises a scanner-deflector.

88. The method of claim 84, wherein said aperture is an output aperture of a lens.

89. The method of claim 84, wherein said aperture is an output aperture of one or more optical fibers.

90. The method of claim 84, further comprising producing a refractive correction.

91. The method of claim 84, wherein said pump beam has a pulse duration of less than about 50 nanoseconds.

92. The method of claim 84, further comprising sensing and compensating for movements of said tissue during a procedure, using an eye tracker.

93. The method of claim 84, decoupling said laser source and said structure using a decoupled laser delivery system.

94. The method of claim 84, wherein said laser source is an erbium YAG laser.

95. The method of claim 84, wherein said laser source is a solid state laser emitting radiation in the wavelength range of approximately 1 to 2 microns.

96. The method of claim 84, wherein said pump beam is designed to produce pulses, and energy of one of said pulses is between about 5 mJ and about 30 mJ.

97. The method of claim 84, wherein said system is designed to produce a spot size on an anterior surface of said tissue having a dimension in the range of about 0.3 mm to about 2 mm.

98. The method of claim 84, further comprising using a corneal topography device.

99. The method of claim 84, wherein said tissue is corneal tissue, and further comprising

evaluating the refraction of said corneal tissue using a spatially resolved refractometer.

100. The method of claim 84 wherein said tissue is corneal tissue.

The claims in pending in US Application No: 10/996,458 do not disclose or suggest the subject matter defined by the pending independent claims, claims 61, 80, 81, 82, 83, and 90.

The claims in pending in US Application No: 10/996,458 do not disclose or suggest the KTP crystal defined by independent claims 61, 81, 83.

The claims in pending in US Application No: 10/996,458 do not disclose or suggest mirror oriented at an angle of forty five degrees relative to said pump beam pulse as defined by independent claim 80.

The claims in pending in US Application No: 10/996,458 do not disclose or suggest the periodically poled LiNbo3 as defined by independent claim 82.

The claims in pending in US Application No: 10/996,458 do not disclose or suggest transmitting said pump beam pulse into a crystal along a propagation direction, as defined by independent claim 90.

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BTM/RAN
Date/Time: September 14, 2007 (8:29am)
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